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Geologic Conditions and DNAPL Migration at Fields Brook in EU-8

Prepared for

Fields Brook Action Group

Prepared by

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Geological Conditions and DNAPL Migration at Fields Brook in EU-8

I am Joseph R. Kolmer, P.E. and I prepared this report. I work for Civil and Environmental Consultants, Inc. (CEC) in their Columbus, Ohio office, and I was retained by the Fields Brook Action Group to review site conditions, specifically those conditions related to DNAPL migration. I am familiar with the Fields Brook site conditions, since I have worked in this area since the early 1990's. In addition, I am familiar with chlorinated solvents (DNAPL chemicals), and I have worked on DNAPL issues since the late 1970s. I have a B.S. Degree in Geological Engineering from St. Louis University (1968) and a M.S. in Earth Sciences from the University of Tulsa (1972). Overall, I have been involved in environmental work for approximately 35 years as identified in my resume, which is included in the Appendix of this report.

I am very familiar with the Fields Brook area. I have reviewed numerous documents, reports, data, and files concerning the environmental conditions at the Brook, and I was involved in the Brook clean-up activities in 2000/2001. I will be discussing several topics in this report. First, I will explain the geologic conditions in the Site area. The second set of topics relate to the mistakes and misinterpretations made by Detrex concerning the conditions at their site, which is immediately adjacent to the Brook. These issues include (1) a misinterpretation of the Site geologic conditions, (2) a misrepresentation of the DNAPL source area at the Detrex facility, and (3) the incorrect positioning of the DNAPL source containment system at the Detrex facility. The improper location of the source containment system has resulted in a continuing migration of DNAPL toward and into Fields Brook, even until this day. Finally, I will discuss the migration of DNAPL from the Detrex source area to the Brook.



Site Area Geological Description

The geologic conditions I discuss in this report focus to the area of the Detrex Facility within the Fields Brook Superfund site. The Detrex property lies east of State Road, just north of the Brook itself, and a depiction of the property is shown in Figure 1. I will use a geologic cross-section to describe the subsurface conditions in this area, and the location of the cross section is north-south through the eastern portion of the Detrex facility, as indicated in Figure 1.

The cross-section itself is shown in Figure 2. The lower most geologic unit in the Site area is the shale bedrock. This bedrock unit consists of a fractured Devonian shale and is a water bearing stratum.

The bedrock shale is overlain by a glacial till, termed the Ashtabula Till in this locale. This till consists of a clayey silt which also contains sand and gravel. This till unit is also fractured, and I will discuss the significance of this fracturing during the discussion concerning DNAPL migration later in this report.

The till unit is overlain by a glaciolacustrine clay. This clay is notably over consolidated and is also fractured. This clay also contains intermittent sand seams, and has a distinctive bluish gray color, which makes it easily identifiable when an excavation penetrates the top of this unit. The overburden material, which is composed of fill and reworked lacustrine clay, forms the surface material across the site area.

The cross-section also shows the location of the Detrex historical process lagoons, which were in the eastern portion of their facility. The exact depth of these



lagoons is not known, but they did penetrate into the lacustrine clay, which is illustrated in Figure 2. During the historical Detrex operations these lagoons received significant quantities of wastes containing DNAPL.

Detrex Depiction of Geologic Conditions was Incorrect

Detrex retained URS/Woodward Clyde Consultants as their environmental consultant for site characterization and development of a source containment remedial program for their facility. Based upon the subsurface investigation work conducted at the Detrex facility, a depiction of the top of the till layer was developed by Detrex, and this map is shown in Figure 3. Based on this geologic description, Detrex developed an understanding of subsurface conditions and used this understanding to assess DNAPL migration conditions across their facility. Figure 3 also illustrates their general conclusions regarding subsurface chemical migration. It appears that since the glacial till contour map showed a high area of till in the south-central to southeast portion of their facility, Detrex presumed that there was a ridge in the till that would prevent DNAPL migration to the south. Thus, Detrex presumed that the DNAPL flow path was to the northwest and to the west along the northern edge of the Detrex property, as illustrated in Figure 3. Based on this understanding/presumption, Detrex installed their source containment system, a soil bentonite slurry cut-off wall, in the northwestern corner of its facility.

Detrex used geologic information obtained from drilling work conducted at their facility to construct their map of the till layer. I have reviewed the underlying geologic data, and these data do not support the Detrex depiction of the till layer; rather the data show that the Detrex till contour map is incorrect. A specific



example of the erroneous nature of the Detrex work is easily illustrated by a review of the drilling log for monitoring well DETMW04S, which is shown in Figure 4. The ground surface elevation at this drilling location was reported to be 632.9 feet. The depth of the boring was 15 feet, which means the bottom of the hole was at elevation 617.9 feet. Referring back to Figure 3, Detrex reported that the elevation of the top of till at this location was 612.9 feet, which is 5 feet below the bottom elevation shown on the drilling log. In addition, a review of the drilling log shows that the till unit itself was not encountered in this boring. That is, the log only reports the presence of the lacustrine clay. Therefore, this drilling location cannot be used to map the top of the till layer.

I reviewed all of the available drilling logs used by Detrex to construct their till map, and less than half of the data points used to construct their map were supported by the underlying geologic information. The map in Figure 5 shows the actual well locations where till was shown on the boring logs. It is obvious that these five drilling locations could not be used to construct the geologic depiction developed by Detrex (Figure 3). Therefore, the geologic conditions presented by Detrex are incorrect. In addition, the presumed migration of DNAPL to the northwest and west across the Detrex facility, as illustrated in Figure 3 is also incorrect, as is the statement from the 1997 ROD, which is also reproduced in Figure 3.

Detrex Depiction of the DNAPL Source Area was Incorrect

Investigative work conducted by Detrex was used to delineate the area of the historical process lagoons on the Detrex facility as well as the area into which DNAPL from these process lagoons had migrated. Figure 6 shows these areas. The blue cross-hatched area encompasses the general location of the historical



process lagoons, and the red cross-hatched area approximates the extent of subsurface DNAPL migration, as interpreted by Detrex. A review of file information, however, shows that there were additional DNAPL findings that Detrex did not include on their drawing. Figure 7 shows these additional known locations of DNAPL. One location is immediately north of the DNAPL migration area (red cross-hatch) depicted by Detrex. The "X" at this location (see Figure 7) represents a monitoring well on the RMI Sodium facility immediately north of the Detrex property. This monitoring well contained significant quantities of DNAPL that had migrated from Detrex, and this location should have been identified on the Detrex map, and the DNAPL area expanded to include it. Similarly, a soil boring was drilled along the northeast side of the DNAPL migration area, and this boring encountered so much DNAPL that it had to be redrilled. Similarly, this location should have been identified on the Detrex map, and it was not. These two northern locations indicate that DNAPL has migrated from the historical process lagoons to a greater extent than the map depiction provided by Detrex. In actuality, it is not known how far this migration actually extends. There is no drilling information in the immediate vicinity of the northern edge of the DNAPL migration area that would define its boundary.

DNAPL was also found on the southern edge of the Detrex property in a monitoring well adjacent to Fields Brook (see Figure 7). This DNAPL finding was in a monitoring well that had been drilled by Detrex as part of their facility investigation. It was well understood that discharges containing DNAPL materials were routed along an open ditch from the Detrex process area into Fields Brook as depicted in Figure 7. This information in conjunction with the finding of DNAPL at the monitoring well adjacent to the Brook, should have been used to expand the DNAPL migration area southward toward the Brook itself.



Overall, when these omissions concerning DNAPL migration from the original source area are considered, it can be seen that DNAPL migration from the historic process area was significantly greater than depicted by Detrex in 2000 in their report to the US EPA.

Detrex Source Containment is in the Wrong Location

The 1997 ROD specifically cites the slurry wall that formed the Detrex source containment system and states that, "The slurry wall component will extend beyond the down gradient portion of the onsite and offsite DNAPL and dissolved phase COCs plume, and be located outside of the DNAPL and extended to insure that the DNAPL and contaminated water flowing towards Fields Brook and the DS Tributary particularly along the northern and western directions from the Detrex facility would be contained or captured." The slurry wall that was installed to effect source containment on the Detrex property did not fulfill the stated objective because it was installed in the wrong location. It has already been shown that Detrex had an incorrect understanding of the geologic conditions of the site and that they also did not accurately depict the extent of DNAPL migration from the historical process lagoon source area. The development and design of the source containment program relied upon these erroneous data, and therefore, it was also incorrectly located.

The slurry wall location, as discussed previously, is in the northwestern corner of the Detrex property. Figure 8 shows this location, and this figure also contains the above referenced quote from the 1997 ROD. When the slurry wall was installed, DNAPL was encountered at the location of the wall. Given the requirements of the ROD, construction of the slurry wall should have been immediately stopped,



and site conditions should have been re-evaluated so that the containment system could have been positioned to satisfy the ROD requirements. In addition, DNAPL was found in the DS Tributary in 2005 at the location depicted in Figure 9. It is not known if this DNAPL migrated past the slurry wall before it was installed, or if this migration occurred subsequent to the containment system installation. In either case, the slurry wall is not satisfying its requirement for containment of DNAPL within the Detrex facility. In addition, during the summer of 2006 additional DNAPL was found along the DS Tributary west of the slurry wall location. Obviously, the Detrex source containment slurry wall is ineffective, because it was placed in the wrong the location and/or because it is not operating in accord with its design specifications.

There are numerous additional conditions dictated by the ROD that were not satisfied by the Detrex source control system. For example, the ROD states that a slurry wall of approximately 1,500 feet should be installed in a location beyond the leading edge of the DNAPL. The installed slurry wall was approximately 450 feet long, and as illustrated above, was installed in the DNAPL, not beyond the leading edge. Additionally, the source containment system design called for the installation of approximately 45 vacuum enhanced extraction wells. Only 12 such vacuum wells have been installed to date, of which only three to four operate satisfactorily. Approximately 10,000 gallons of DNAPL has been extracted over a three year period, compared to an estimated 250,000 to 500,000 gallons of DNAPL in the subsurface. This information shows that the Detrex source containment system is ineffective, besides being located improperly.



DNAPL Migration Across the Detrex Property

When Detrex constructed their map of the till, they assumed that the till formed a barrier to DNAPL migration. This assumption is not correct, and the DNAPL not only migrates through the till material, but also along the interface between the till and the lacustrine clay, and on top of the lacustrine clay, and through the fracture network and the sand seams in the lacustrine clay layer.

The fact that DNAPL migrates through the fracture network and sand seams in the lacustrine clay is well documented by the available field information. Figure 10 shows information provided by Detrex based upon their site investigation program. The blue cross-hatched area represents the approximate location of the original DNAPL source area, and the red cross-hatch represents a portion of the area where DNAPL has migrated. The monitoring wells that were used to document this DNAPL migration were all drilled into the lacustrine clay, and the height of DNAPL in each monitoring well is depicted in the Figure. In other words, DNAPL migration through the lacustrine clay from the original source area was sufficient to cause an accumulation of approximately one foot to over thirteen feet of DNAPL in the lacustrine clay. This is significant DNAPL migration. Any time DNAPL is observed in a monitoring well outside of its original source area, it means that significant migration has occurred.

It is also known that DNAPL has migrated beyond the edge of the red cross-hatched area depicted in Figure 10. The previous discussion showed that known locations of DNAPL migration were not considered by Detrex when they constructed their DNAPL map (see Figure 7). In addition, more recent field information indicates a much broader pattern of DNAPL migration than originally



depicted by Detrex. It has been shown that DNAPL has migrated westward from the original source area past the location of the Detrex source containment system into the DS Tributary. In addition, indications of DNAPL were also observed in utility manholes along State Road, at the locations shown in Figure 10. Finally, during the original cleanup of DNAPL in Fields Brook in 2000/2001, DNAPL was found in an upland area (above the elevation of the Brook) on the East side of State Road, where Fields Brook crosses under State Road, as shown in Figure 11. DNAPL was also found in this same area on the west side of State Road adjacent to the north sewer. This latter finding is also in an upland area. DNAPL migration to these locations occurred via a subsurface route, through the geologic layers at the site. I have calculated the minimum rate of DNAPL migration based upon these DNAPL findings. The distance from the location of the historic process lagoons to the intersection of State Road and Fields Brook, where DNAPL was found in the subsurface, is approximately 1,500 feet. Solvent manufacturing operations at the facility commenced in the 1950s, some fifty years before the DNAPL was observed. These findings show that the DNAPL migration rate was at least 30 feet per year through the subsurface materials, and is probably faster because the DNAPL appeared to have accumulated in the areas where they were observed, which means that the DNAPL arrived at these locations some time before it was observed.

The 2005 investigation work in this portion of Fields Brook in conjunction with previously available information has been used to generate a topographic map of the top of the lacustrine clay. This map is shown in Figure 11. The slope of the top of the clay across the Detrex facility is towards Fields Brook. Thus, DNAPL migrating from the Detrex source area along the top of the lacustrine clay would move toward the Brook. In addition, numerous paleo-erosional channels were



present in the top of the lacustrine clay, and these channels would have enhanced DNAPL migration toward the Brook. In fact, DNAPL findings in the Brook during the 2005 investigation coincided with the location of the paleo-erosional channels in the lacustrine clay, as illustrated in Figure 11. The findings of DNAPL in the Brook itself in 2005, as well as the findings of DNAPL in upland areas adjacent to the Brook along State Road, show that DNAPL has migrated through the subsurface geologic materials from the source area to the Brook and other areas adjacent to the Detrex facility.

There was not sufficient information to construct a topographic map of the top of the till layer. As discussed above, there were very few data points that actually penetrated the lacustrine clay and encountered the till layer. There were, however, five data points south of the historical process lagoons that could be used to assess the slope of the till unit. Based upon these data, the till slopes to the south-southwest in the southern portion of the Detrex property. Therefore, DNAPL migrating along the interface between the till and the lacustrine clay would also migrate toward Fields Brook.

The cross section used above to discuss the geologic conditions of the Fields Brook area is shown again in Figure 12 to illustrate the pathways of DNAPL migration away from the Detrex source area. DNAPL migrated from the process lagoons along the top of the lacustrine clay. This migration pathway was documented by RMI Sodium when they constructed a drainage ditch along their southern property boundary. When this ditch was excavated to depth (intersecting the top of the lacustrine clay), DNAPL flowed from the Detrex property into the ditch. The ditch was excavated in a shallow configuration to avoid this DNAPL exposure.



DNAPL has also migrated through the glacial lacustrine clay, which is documented by the findings of DNAPL in the monitoring wells installed in the clay. Several of these monitoring wells are shown in the cross-section at Figure 12 and include MW-05, MW-07, MW-09, and MW-10. Figure 10 shows that relatively large quantities of DNAPL were historically observed in these monitoring wells. Migration of DNAPL beyond these well locations has also occurred, because the DNAPL has been observed in upland areas in the vicinity of Fields Brook and State Road. DNAPL at these locations also migrated through the subsurface materials. The cross section at Figure 12 illustrates this migration pattern through the lacustrine clay, at the interface between the lacustrine clay and the Ashtabula Till as well as through the till itself.

Conclusions

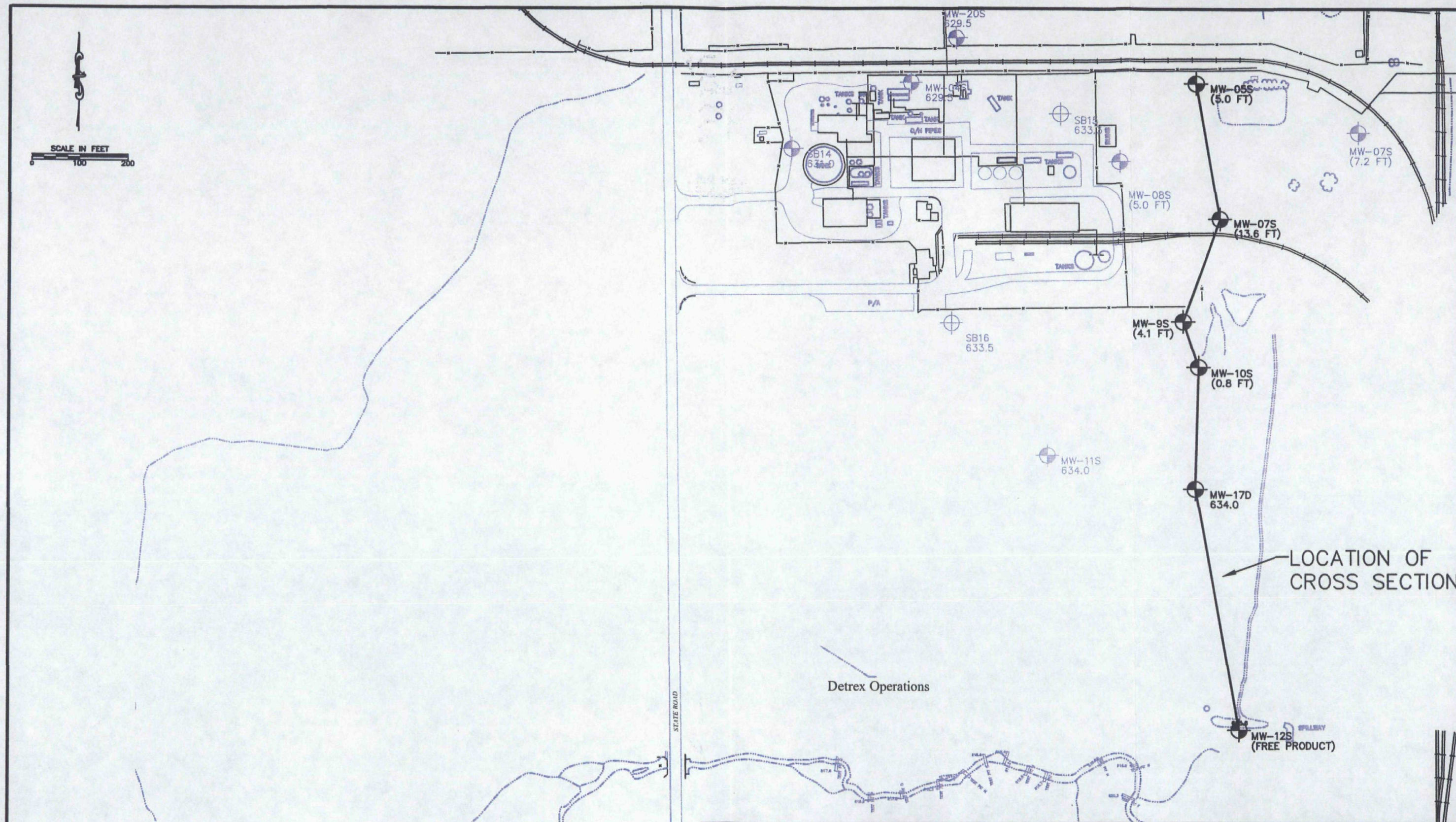
I have developed the following conclusions based upon the above reported information.


1. The map of the till layer which Detrex used as their geologic site model was incorrect. This incorrect geologic model was used to support the presumption that DNAPL migration to the south was blocked by the till, and migration occurred only to the northwest across the Detrex facility. DNAPL migration has not only occurred westward from the Detrex facility, but has also occurred southward from Detrex into Fields Brook and this migration pathway continues unmitigated.

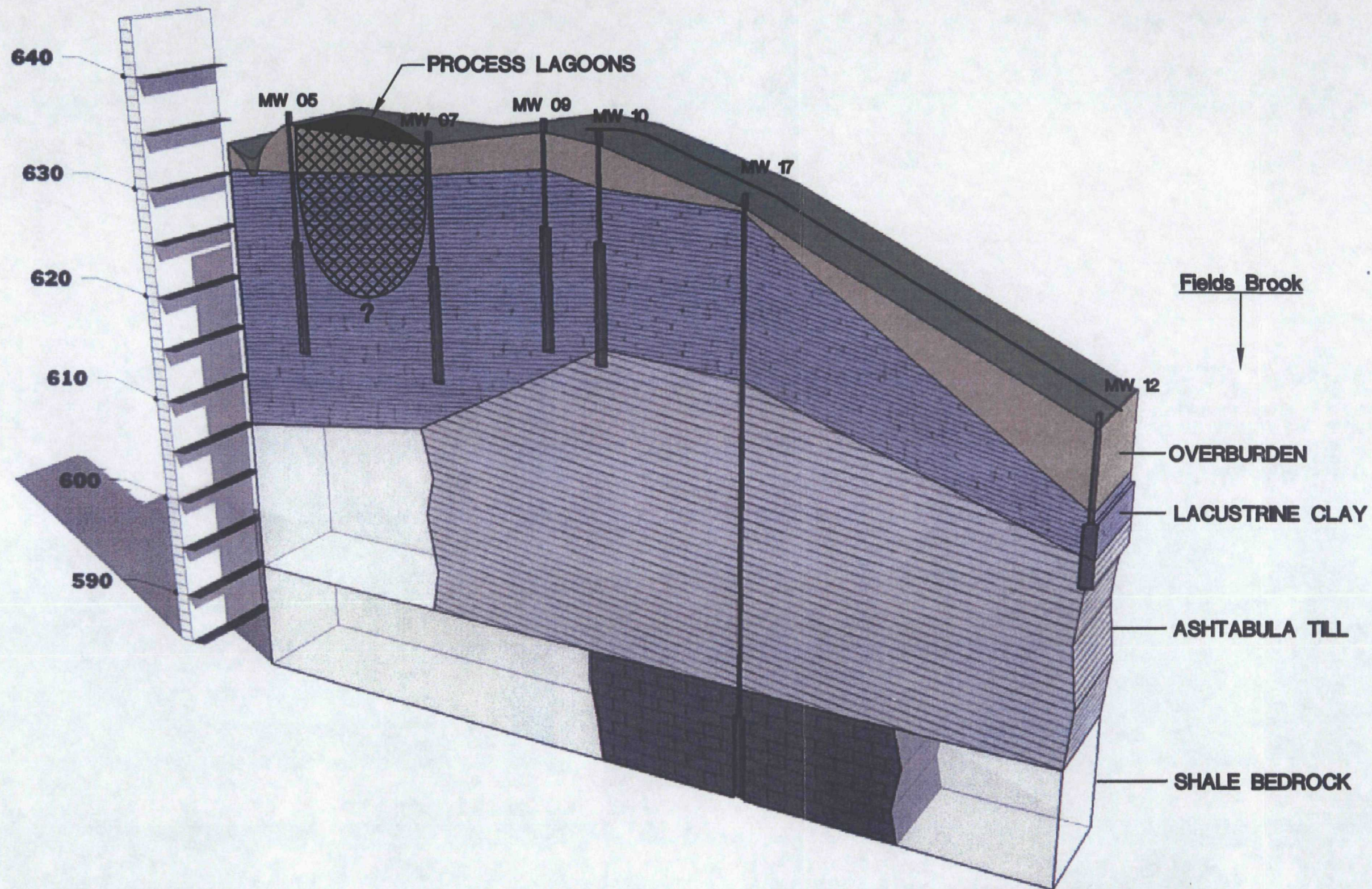



2. The map of the DNAPL migration area submitted by Detrex to the US EPA in 2000 did not illustrate the entire DNAPL migration area. In fact, subsequent data has shown that DNAPL migration from the historical Detrex source area is much more significant than previously presented.
3. The Detrex source containment program consisted of a soil bentonite slurry wall and a pump well system that was installed in the northern portion of their property. This slurry wall was installed in the wrong location and was not installed in conformance with the 1997 ROD requirements. DNAPL was present at the wall location when it was installed and subsequent findings show that significant DNAPL migration to the DS Tributary has occurred.
4. There is no source containment or mitigation of DNAPL migration from the Detrex source area to Fields Brook. DNAPL migration to Fields Brook continues at a minimum rate of 30 feet per year, and will continue until an adequate source containment system has been designed and installed.

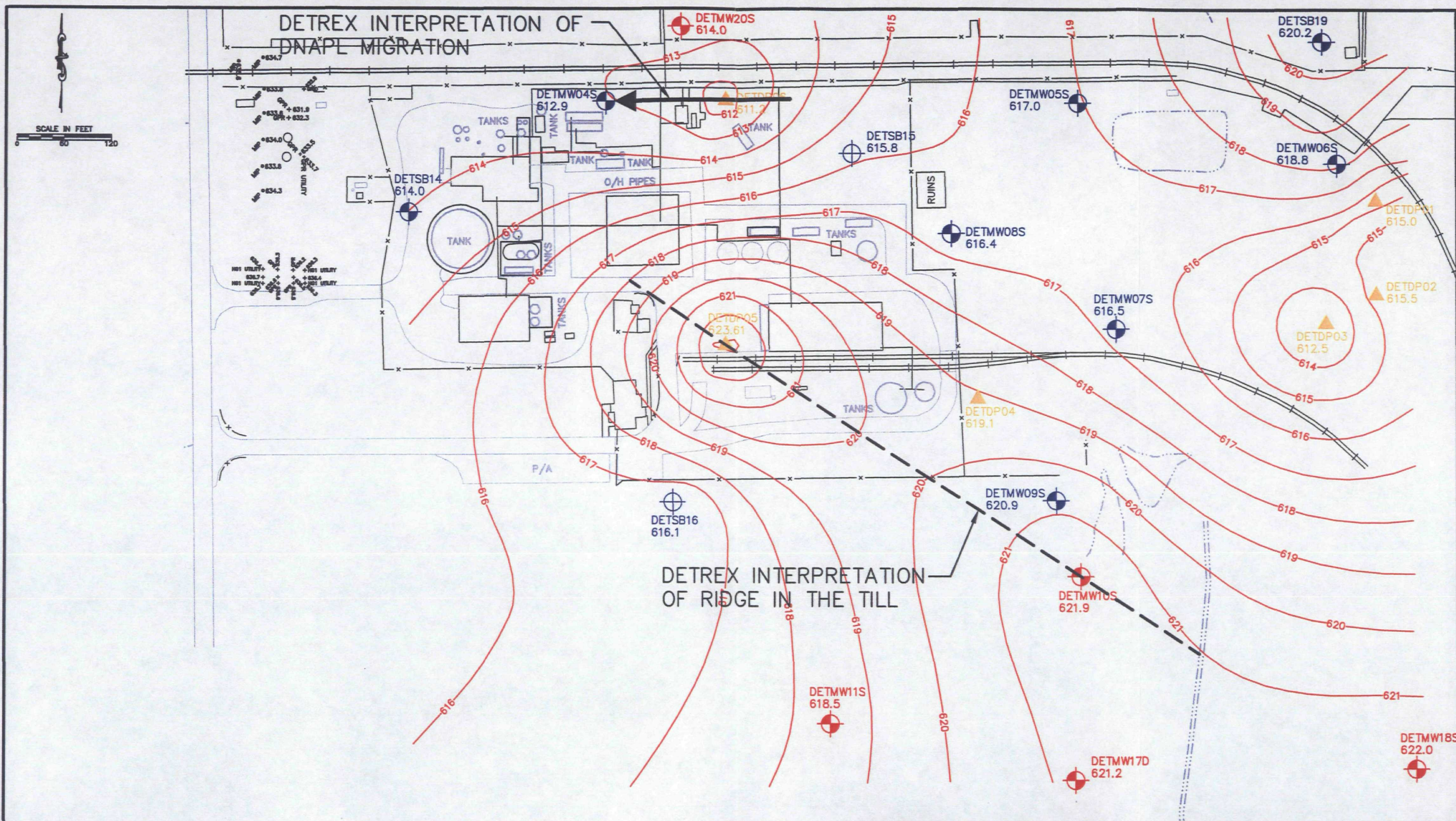




 Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			DETREX FACILITY AND LOCATION OF GEOLOGIC CROSS-SECTION	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO.: 051372	FIGURE NO.: 1



 Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			GEOLOGIC CROSS-SECTION	
DWN. BY: JSC	SCALE: N.T.S.	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 2
CHKD. BY: JRK				



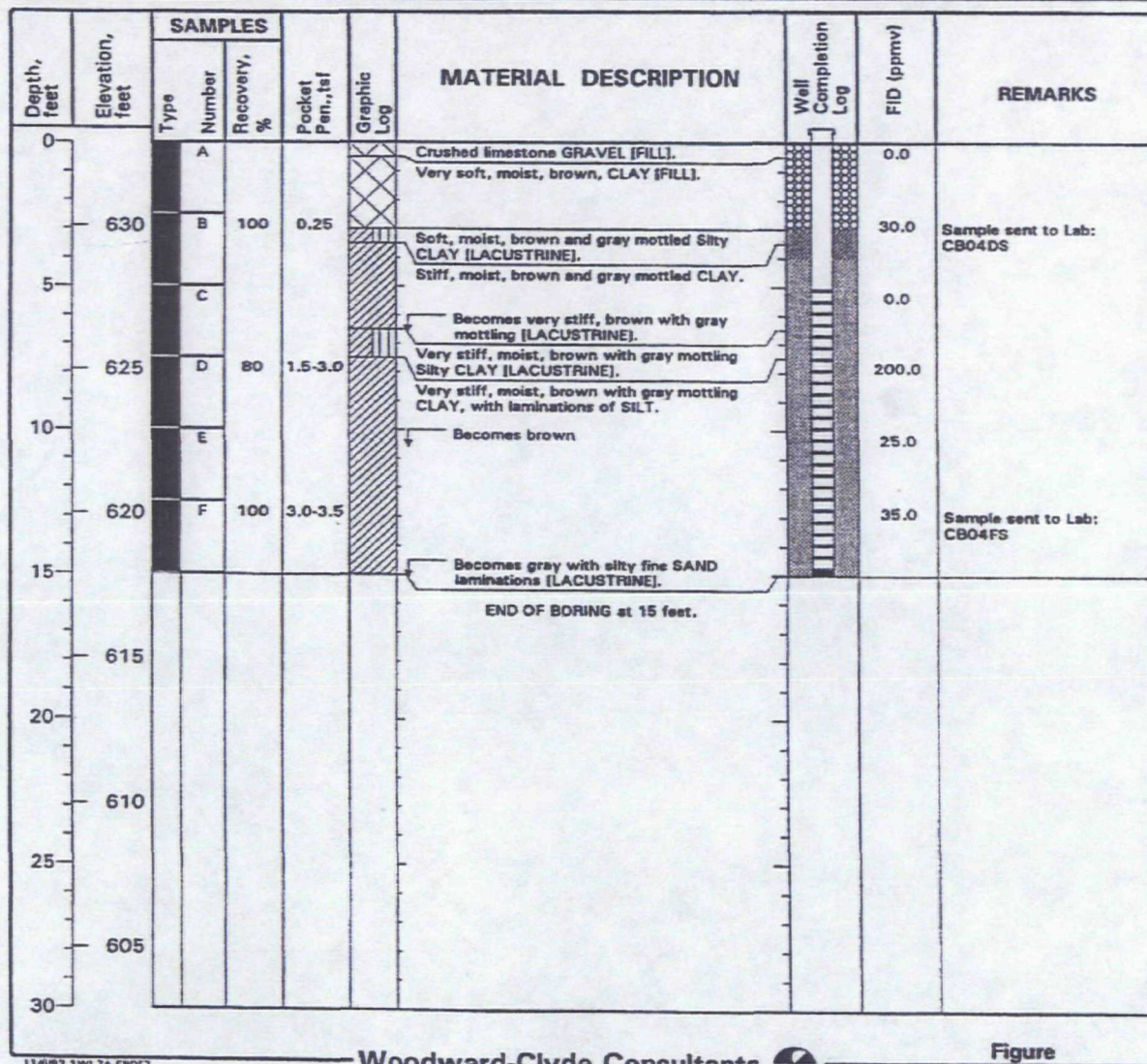
THE 1997 ROD STATES:

"Based on data collected to-date, the DNAPL plume is migrating toward the northwest, consistent with groundwater flow and the structure of the top of the underlying till layer."

 Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			DETREX MISUNDERSTANDING OF THE IMPACT OF THE TILL LAYER	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 120'	DATE: AUG 2006	PROJECT NO.: 051372	FIGURE NO.: 3

Project: Fields Brook Superfund Site - Ashtabula, Ohio	Log of Boring DETMW04S
Project Number: 86C3609K	Sheet 1 of 1
Boring Location: Detrex Corporation	

Date(s) Drilled	1/4/93, 1/5/93	Logged By	M.T. Schmidt	Checked By	J.A. Ozimek
Drilling Method	Hollow stem auger	Auger Bit Size/Type (in. I.D.)	4.25	Approx. Surface Elevation (feet, MSL)	632.9
Drill Rig Type	Falling F-7	Drilled By	Lahti Drilling	Total Depth Drilled (feet)	15.0
Groundwater Elevation (feet, MSL)	627.30 7/27/93	Number of Samples	Collected: 6	Analyzed: 2	Sampler Type
Diameter of Hole (inches)	8.25	Diameter of Well (inches)	2	Type of Well Casing	PVC riser /Stainless Steel Screen
Type of Sand Pack	20 mesh	Type/Thickness of Seal(s)	1 ft bentonite pellets.	Screen Perforation	0.010 in.
Comments				Top of Well Casing Elevation (feet, MSL) 634.44	




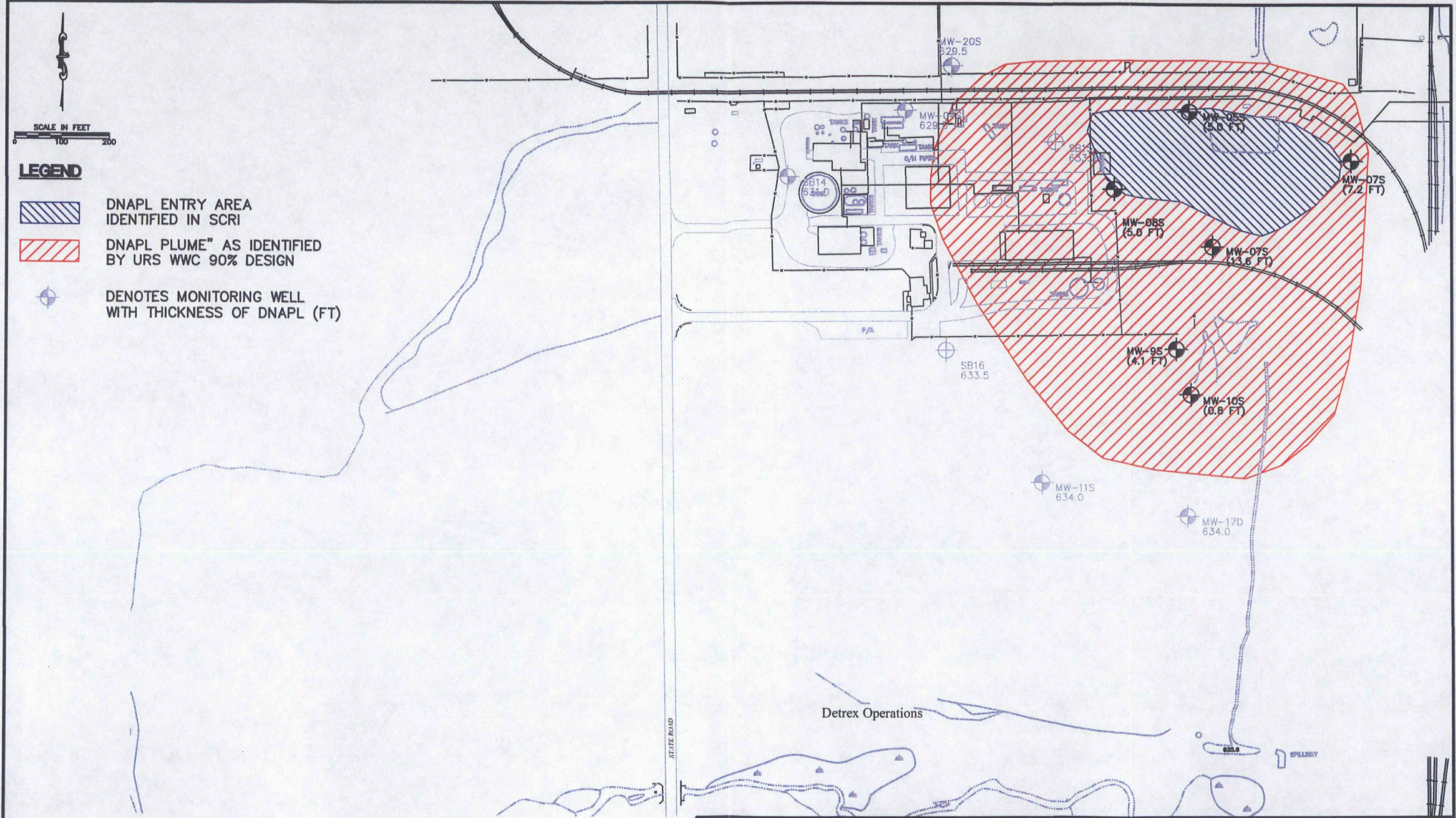
Surface elevation = 632.9 ft


Depth of Boring = 15 ft

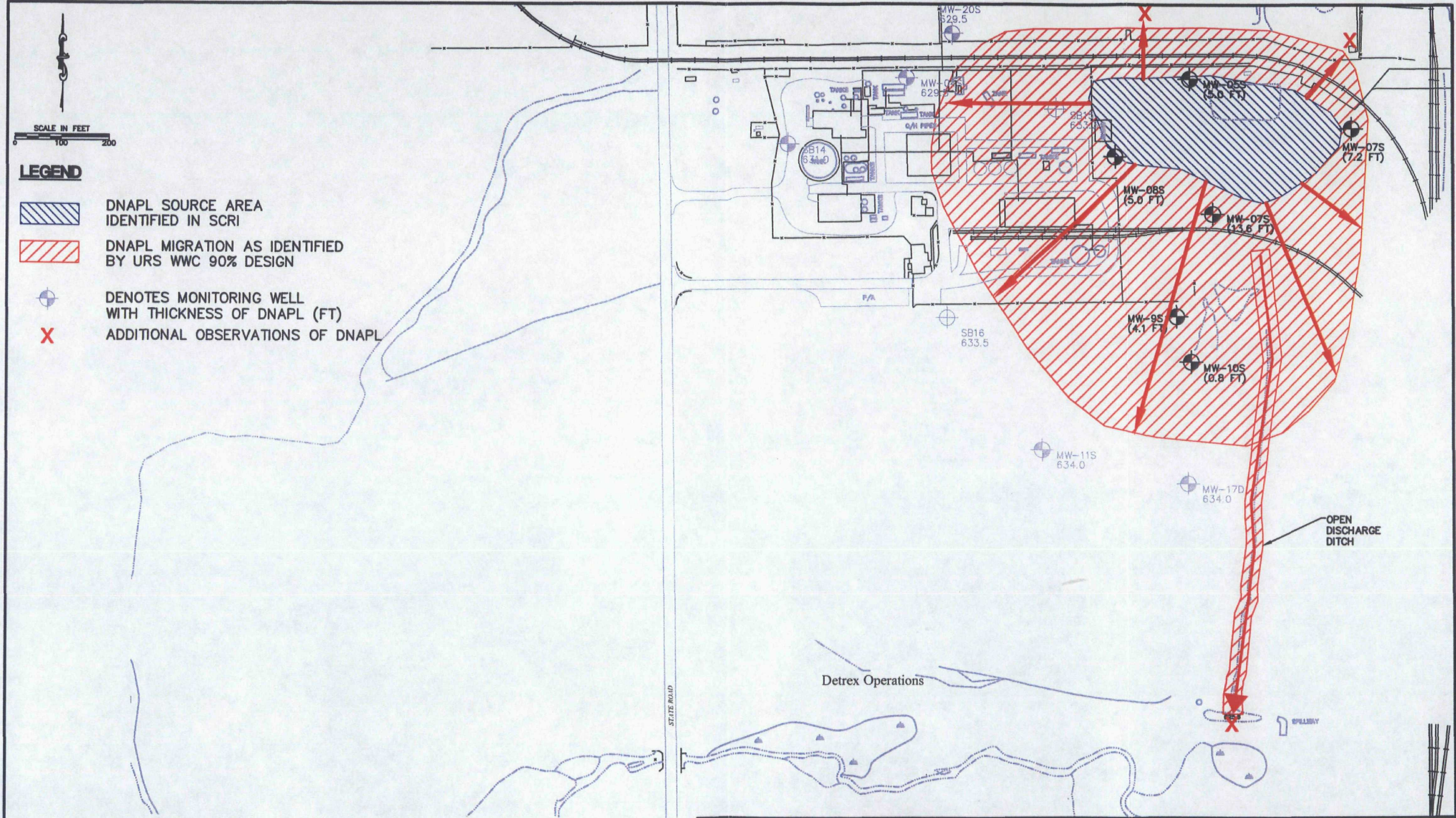
Bottom of hole elevation = 617.9 ft

Elevation used on Detrex map was 5 ft below bottom elevation, i.e. est. 612.9 ft

 Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			DRILLING LOG ANALYSIS FOR DEPTH TO TILL	
DWN BY: JSC CHKD BY: JRK	SCALE: N.T.S.	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 4



 Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			DETREX DEPICTION OF DNAPL PRESENCE	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 6

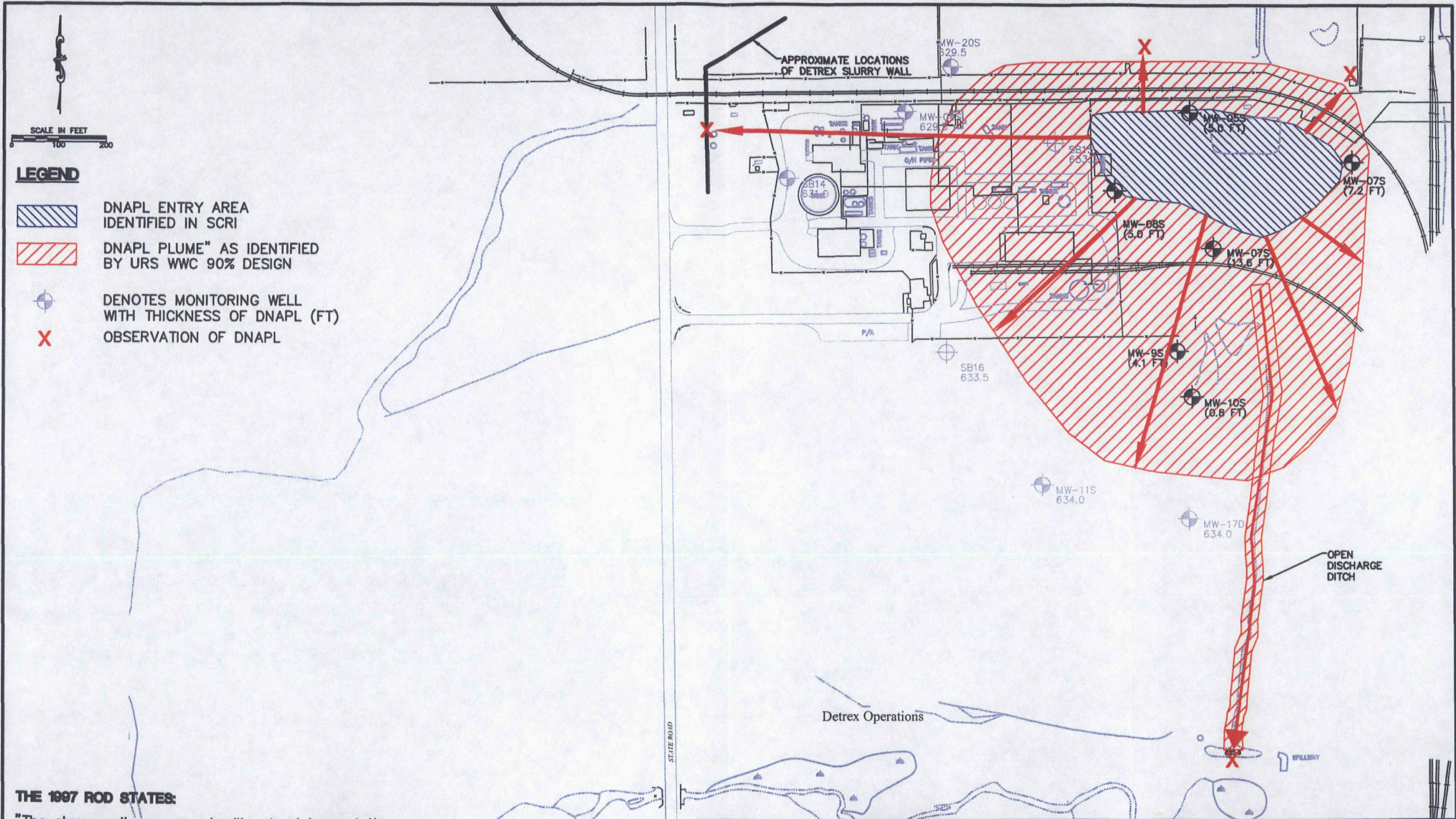


SCALE IN FEET
0 100 200

LEGEND

- DNAPL SOURCE AREA IDENTIFIED IN SCRI
- DNAPL MIGRATION AS IDENTIFIED BY URS WWC 90% DESIGN
- DENOTES MONITORING WELL WITH THICKNESS OF DNAPL (FT)
- X ADDITIONAL OBSERVATIONS OF DNAPL

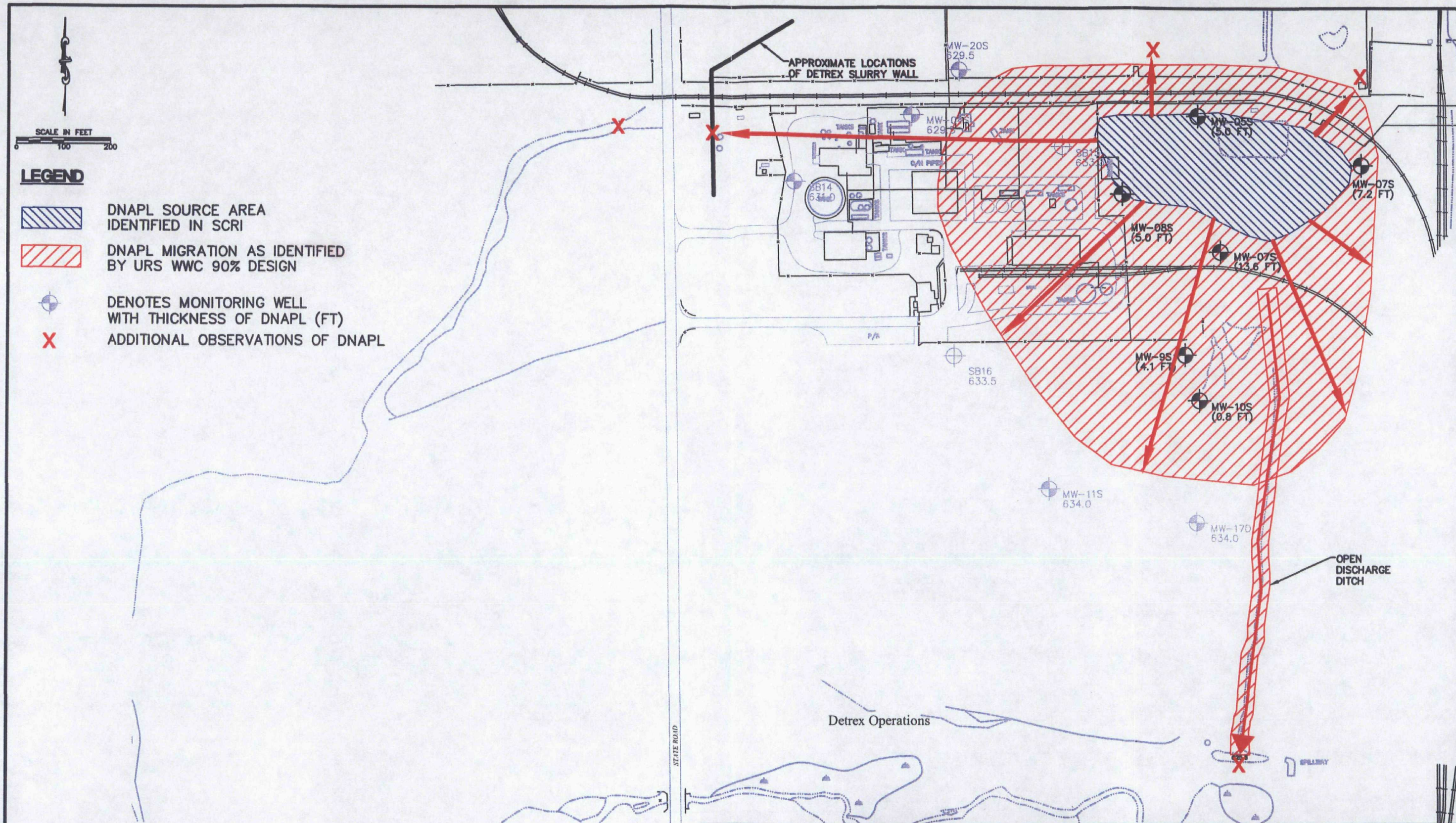
<p align="center">CEC Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN</p>			ADDITIONAL DNAPL LOCATIONS OUTSIDE OF THE DNAPL AREAS IDENTIFIED BY DETREX	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO.: 051372	FIGURE NO.: 7



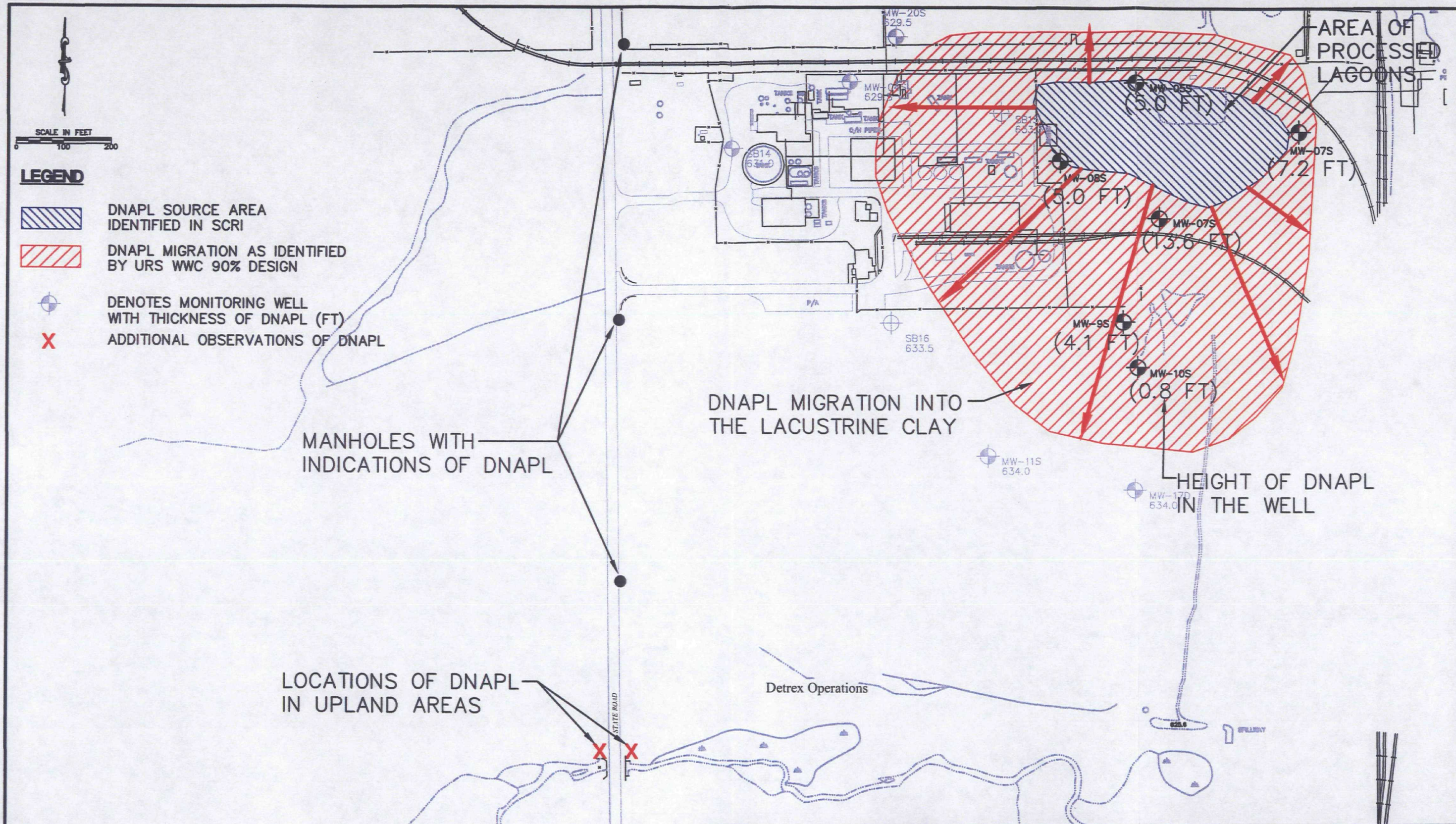
THE 1997 ROD STATES:

"The slurry wall component will extend beyond the downgradient portion of the on-site and off-site DNAPL and dissolved phase COCs plume, and be located outside of the DNAPL and extended to ensure that the DNAPL and contaminated water flowing towards Fields Brook or the DS Tributary particularly along the northern and western directions from the Detrex facility would be contained or captured."

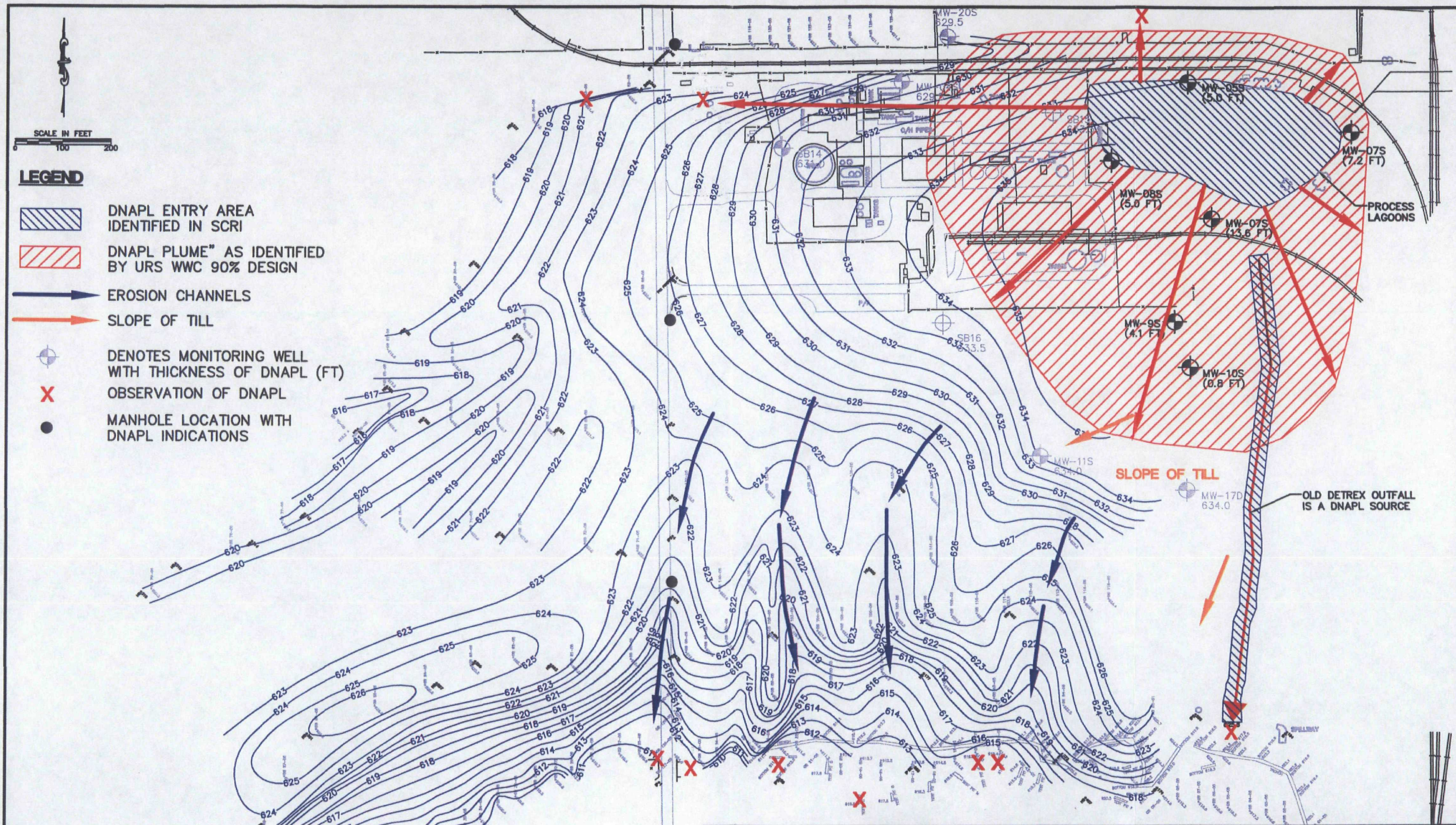
Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			LOCATIONS OF ADDITIONAL POINTS OF DNAPL MIGRATION	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 8




Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			LOCATION OF DNAPL MIGRATION IN THE DS TRIBUTARY	
DWN. BY: JSC CHKD. BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 9



Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			MIGRATION OF DNAPL INTO AND THROUGH THE LACUSTRINE CLAY	
DWN BY: JSC CHKD BY: JRK	SCALE: 1" = 200'	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 10

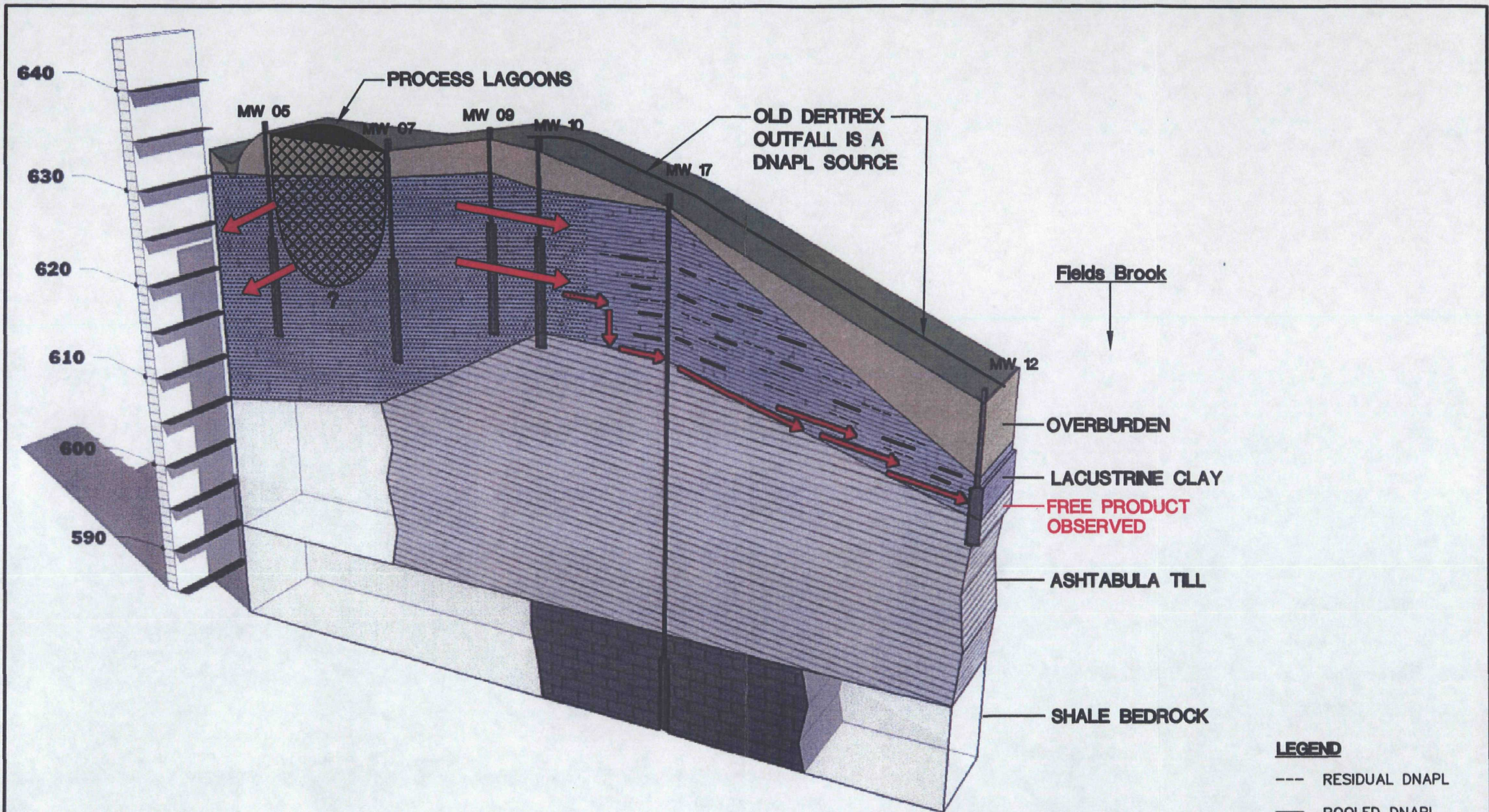


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DWN BY: JSC	SCALE:
CHKD BY: JRK	1" = 200'
DATE:	AUG 2006

DNAPL LOCATIONS AND THE TOP
OF THE LACUSTRINE CLAY
AND THE SLOPE OF THE TILL

PROJECT NO:
051372

FIGURE NO:
11



Civil & Environmental Consultants, Inc. Columbus, OH (614) 540-6633 • (888) 598-6808 Cincinnati, OH • Pittsburgh, PA • Indianapolis, IN • Nashville, TN			CROSS-SECTION OF MIGRATION PATTERN — LACUSTRINE CLAY	
DWN. BY: JSC CHKD. BY: JRK	SCALE: N.T.S.	DATE: AUG 2006	PROJECT NO: 051372	FIGURE NO: 12